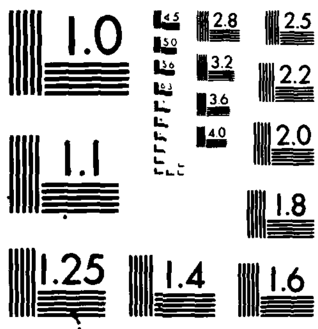
AD-A098 902 NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL S--ETC F/G 8/10
DATA REPORT FOR OCEANOGRAPHIC/GEOPHYSICAL SURVEYS IN THE NORTHW--ETC(U)
MAR 81 J A GREEN, S D TROWELL
UNCLASSIFIED NORDA-TN-81 NL

END
DATE
FILMED
8-81
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

LEVEL II

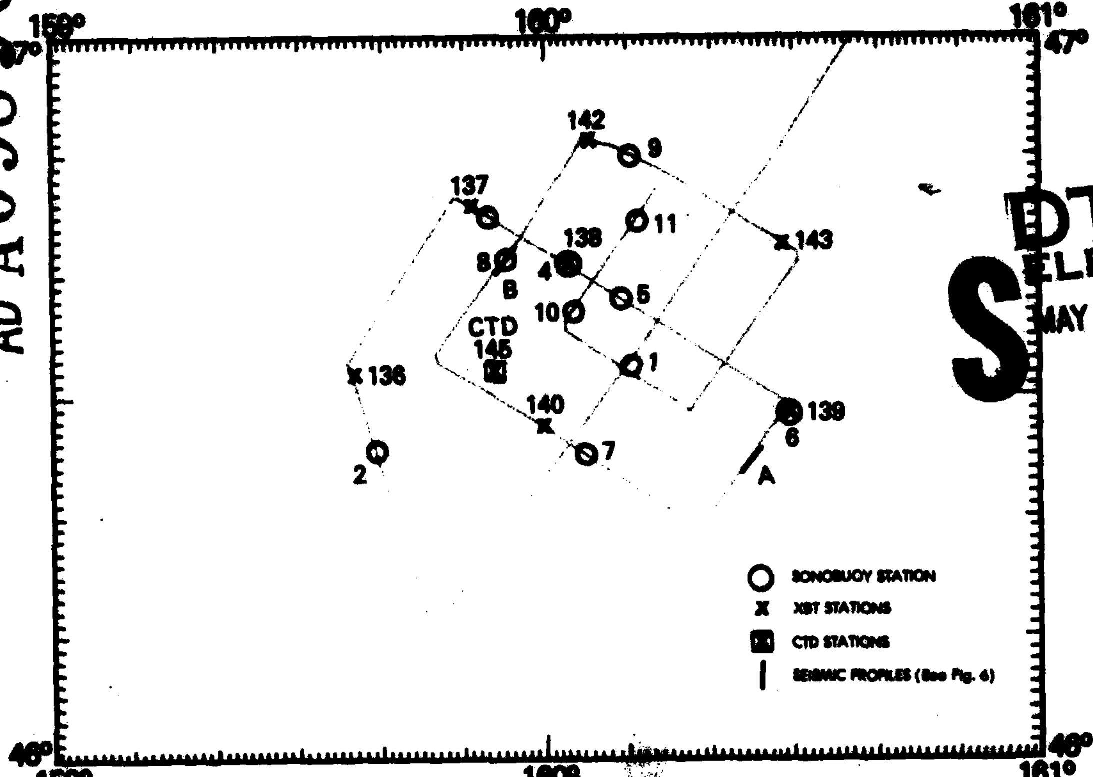
NORDA Technical Note [illegible]

Naval Ocean Research
and Development Activity
NSTL Station, Mississippi 39529

See 1473.

Data Report for Oceanographic/Geophysical Surveys in the Northwest Pacific (46-47°N, 159-161°E): USNS Silas Bent, 2-3 August 1980

AD A098902



J. A. Green
S. D. Trowell

Sea Floor Division
Ocean Science and Technology Laboratory

March 1981

81 5 14 006

ABSTRACT

This note presents the results of a geophysical/oceanographic survey of Area 2 selected from Green and Fleischer (1980). The surveyed area has an average depth of 5300 m and is located on the eastern flank of the Hokkaido Rise. Average unconsolidated sediment thickness is 0.45 seconds of two-way travel time (approximately 400 m). These sediments are probably siliceous clays interspersed with volcanic ash layers and their calculated acoustic interval velocity is 1.770-1.860 km/sec.

The smoothest bottom and most homogeneous geology appear in the northeastern section of the survey area. This section, an area about 25 km x 25 km, has smooth acoustic basement which is present at the northern base of a seamount located at 46.6°N, 159.8°E. Residual magnetic lineations are also present in this area and may represent Cretaceous quiet zone seafloor spreading anomalies.

In the western part of the survey area the bottom and acoustic basement are rougher than in the eastern part. The local geology is less homogeneous because seamounts are present. Residual magnetic anomalies are generally associated with seamounts and no correlatable lineations are apparent.

ACKNOWLEDGEMENTS

The authors wish to thank the NAVOCEANO personnel aboard the USNS SILAS BENT who were largely responsible for the success of the survey of Area 2. R. Merrifield, T. Lennon, J. Rukowitz, and B. Hill were particularly cooperative and helpful.

CONTENTS

ILLUSTRATIONS

I. INTRODUCTION

This note presents the results of a survey of Area 2, which was selected from Green and Fleischer (1980, Fig. 1). The survey was conducted by NORDA and NAVOCEANO during 2-3 August 1980 aboard the USNS SILAS BENT. Data collected consist of eight expendable bathythermograph (XBT) records, one conductivity/temperature/depth (CTD) record, 11 sonobuoy wide-angle reflection records, and approximately 250 km track coverage for each of 3.5 kHz echograms, 12 kHz echograms, continuous seismic reflection profiles and total field magnetics. The sonobuoy data and continuous seismic reflection profiles were collected using two 30 kilojoule sparker sources; the magnetics were collected using a proton precession magnetometer. Track lines were laid out to detect assumed structural trends and to best explore the area within the two days allotted.

The data are compiled in oceanographic and geological sections. The oceanographic section treats temperature and sound speed in the water column. The geological section presents the local geology of Area 2 and includes geophysical maps at a scale of P.S. 4.

II. TEMPERATURE AND SOUND SPEED IN THE WATER COLUMN

Temperature and sound speed models are based upon XBT and CTD records collected during the survey (Figs. 2 and 3). These models represent summer conditions at Area 2. Values for the upper 200 m of the water column should vary seasonally while values for water deeper than 200 m should be relatively constant.

XBT records (Fig. 2) show that a surface mixed layer, a vertical section with homogeneous temperature, is either very shallow or nonexistent. Water temperature is 11-14°C at the surface and drops below 10°C within the upper 20 m. The XBT records also show that the temperature decreases to a local minimum of about 1°C at a depth of 90-150 m, the axis of the sound channel.

The conductivity/temperature/depth (CTD) record shows that the temperature at the axis is 0.82°C at a depth of 117 m (Fig. 3). The record also shows that the temperature increases gradually to 3.5°C at a depth of 290 m and then gradually decreases to 1.48°C at 3217 m, the deepest point of the CTD cast. By extrapolating the curve down to the seafloor, the temperature of bottom water should be approximately 1.1°C.

The instantaneous sound velocity profile shows a shallow mixed layer with the sound velocity increasing slightly from 1491.68 m/sec at the surface to 1491.77 m/sec at a depth of 12 m (Fig. 3). It then decreases rapidly to a minimum of 1452.38 m/sec at 115 m, the axis of the sound channel. Below that depth the sound velocity increases to 1509.18 m/sec at 3217 m. Extrapolating downward to 5200 m, a typical water depth in the area, the instantaneous sound velocity of bottom water should be approximately 1540 m/sec.

The average sound velocity in the water column decreases gradually to a minimum of 1461.95 m/sec at 174 m and increases from there to 1484.85 m/sec at 3217 m. Extrapolating the curve downward, the average sound velocity in the water column reaches approximately 1500 m/sec at an average depth of 5200 m.

III. GEOLOGY

This section presents a compilation and analysis of the geophysical data collected on the 1980 SILAS BENT Cruise. The compilation is occasionally

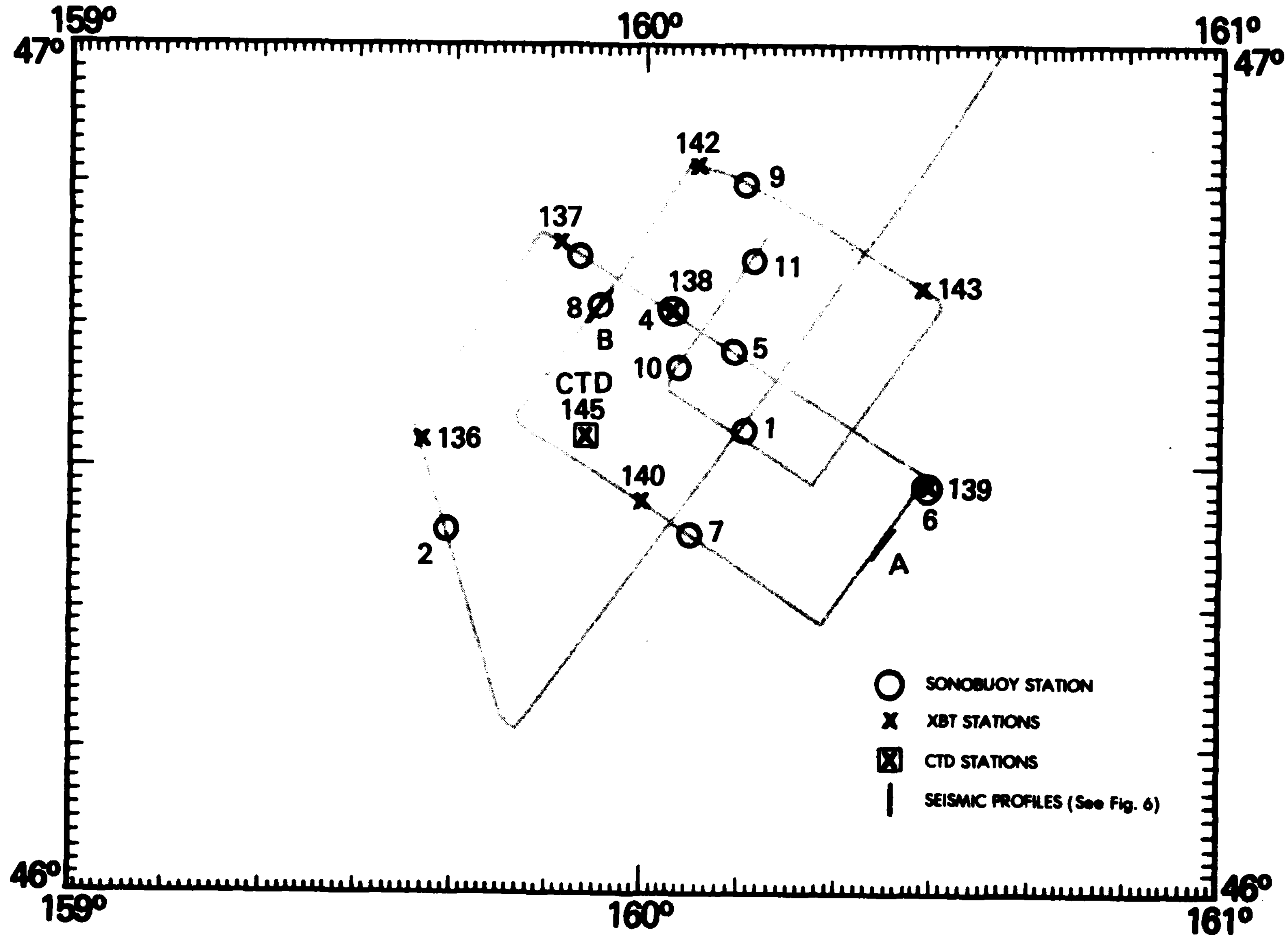


Figure 2. Index map of Area 2 showing track control and locations where specific data were collected during the 1980 SILAS BENT cruise.

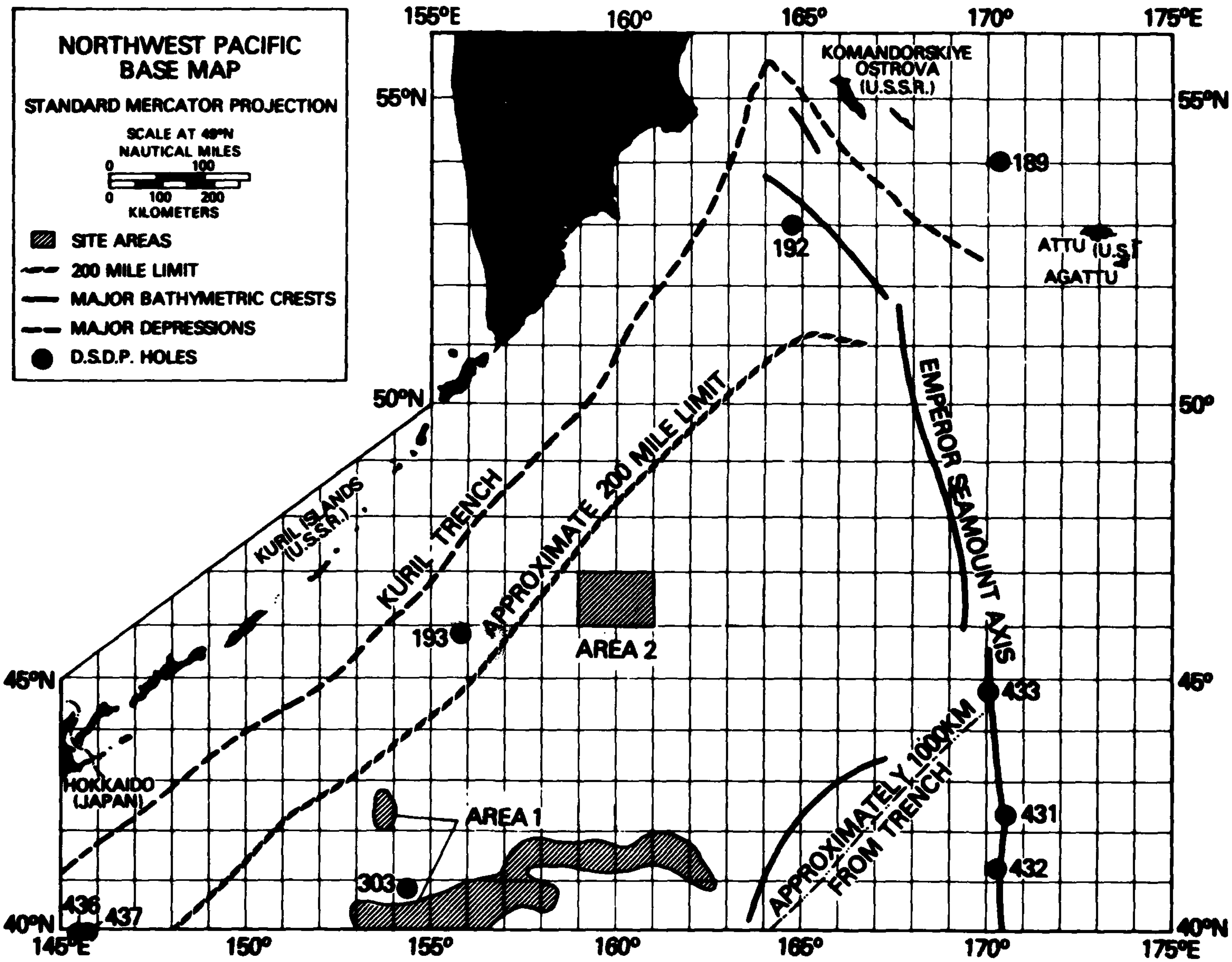


Figure 1. Index map of the Northwest Pacific showing the location of Area 2.

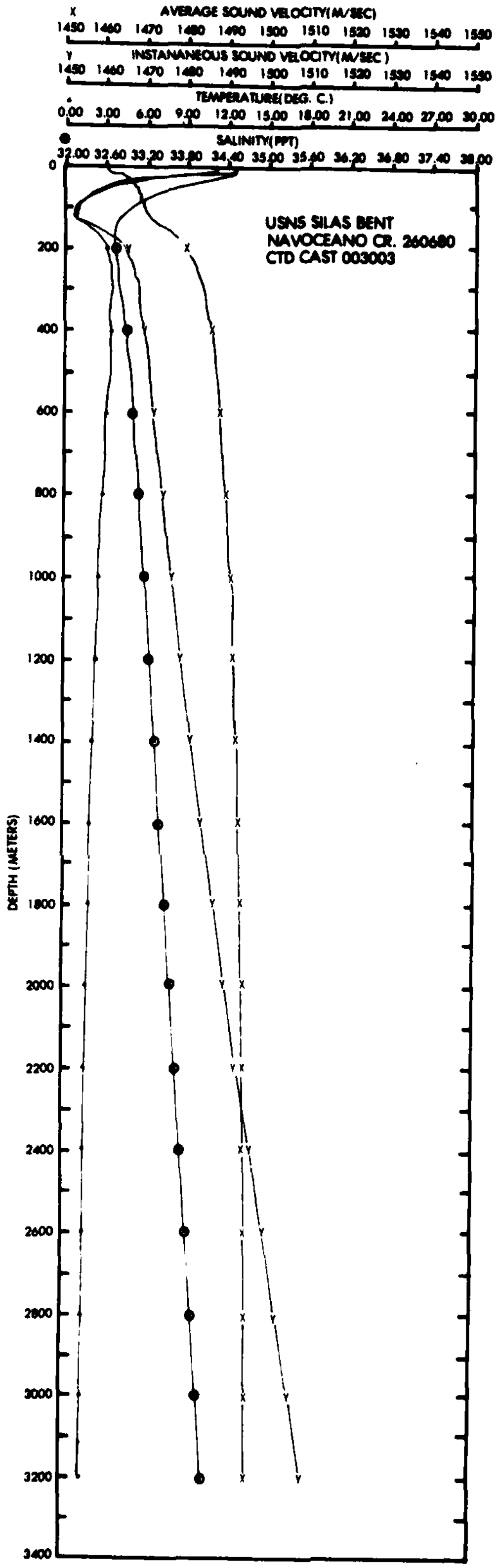


Figure 3. The conductivity/temperature/depth (CTD) profile. The profile was collected at the location indicated in Figure 2.

supplemented by data from the environmental report for the Northwest Pacific (Green and Fleischer, 1980) which the reader should consult for an in-depth analysis of Northwest Pacific geology.

A. PHYSIOGRAPHY

Area 2 is located in an abyssal hills province on the eastern flank of the Hokkaido Rise (Fig. 1). Figure 4 illustrates the physiography of Area 2 by showing bathymetry with bottom roughness superimposed. The northeastern region of Figure 4 shows a smooth bottom which slopes gently to the southeast at an average gradient of about 1/350. Traversing this region is a northeast/southwest-oriented trough which has relief of 50 m. The western area has seamounts and more variable bottom roughness. Roughness is greatest at seamounts. The maximum measured slope is 1:3 and maximum relief is 1400 m for a seamount located at 46.6°N, 159.8°E.

B. SEDIMENTS

Sediment cores were not collected during the 1980 SILAS BENT Cruise; however, two sediment cores were collected by Lamont-Doherty Geological Observatory at locations near Area 2: R/V VEMA 20-123 at 46°15'N, 157°55'E and R/V VEMA 20-122 at 46°34'N, 161°41'E (unpublished LDGO core descriptions). Sediments in these cores represent the upper 13-15 m of the sediment column and contain diatomaceous lutites occasionally interspersed with sandy volcanic ash layers. Rare occurrences include plant material and ice-rafted pebbles. The sedimentation regime represented by these core descriptions has been relatively constant since the Miocene (Green and Fleischer, 1980). Because most unconsolidated sediments at Area 2 are post-Oligocene, these sediments should not differ greatly from the LDGO sediment descriptions.

Physical properties of sediments at Area 2 are best inferred by the analysis of sediments from DSDP site 193, 400 km southwest of Area 2. These analyses are described in Green and Fleischer (1980).

For this technical note, sediment thickness and structure are evaluated on the basis of continuous seismic reflection profiles. Figure 5 shows the thickness of the acoustic transparent layer which is assumed to be unconsolidated sediment. Sediment thickness is greatest toward the northwest (0.5 sec) and thins toward the southeast (0.35 sec). The areas with thicker sediment are nearer the Kuril Islands, a source of volcanic detritus. Western areas of Figure 5 show rough bottom, high relief and variable sediment thickness. For example, the seamount of 46.6°N, 159.8°E has thin sediment on its slopes and a 0.1 sec cap.

Sediments generally drape over acoustic basement; however, local exceptions appear to be caused by faulting, sediment ponding and slumping. Tensional faulting which trends northeast-southwest appears to displace acoustic basement and sediments throughout the area; however, the frequency and age of this faulting is ambiguous on seismic reflection profiles. Also, evidence of sediment ponding exists in the southwestern region where the northwest/southeast-trending trough might act as a sediment channel (Fig. 6A). Slumping of sediments occurs on seamount slopes.

C. SEDIMENT VELOCITIES

Eleven sonobuoys were launched in the area of study for the purpose of computing interval velocities (Fig. 2). Most of the sonobuoy data is unusable because the sea bottom and/or acoustic basement are too rough for reliable sonobuoy data. Sonobuoy station 8 is located within the smoothest part of Area 2, where

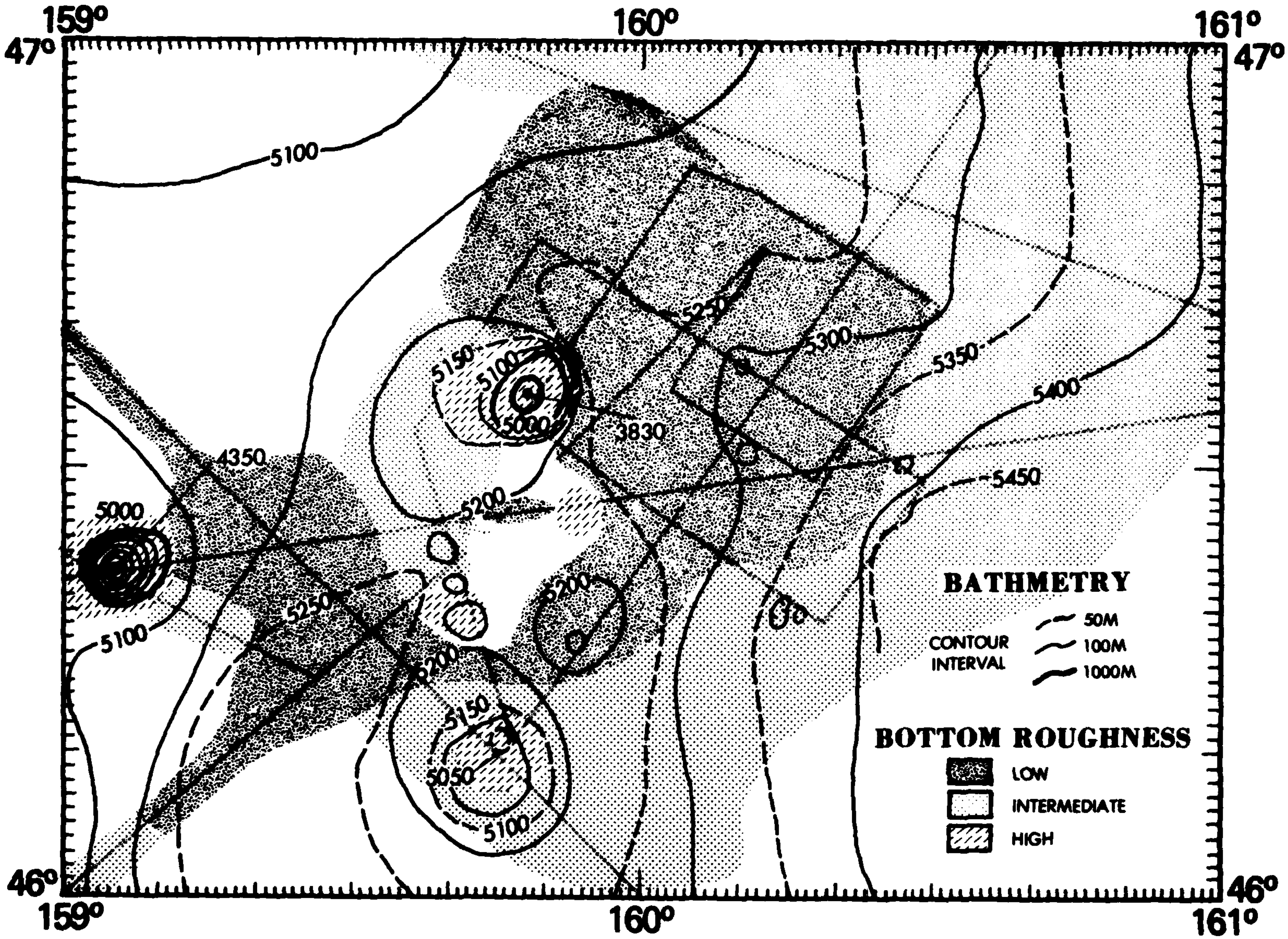


Figure 4. Bathymetry and bottom roughness of Area 2. Bathymetry is based on two-way travel time of 1500 m/sec. Bottom roughness divisions are: low roughness (less than 200 m relief in a 20 km span and/or slopes less than 3-4°); intermediate roughness (intermediate relief and slopes of 3-10°); high roughness (relief greater than 200 m in a 20 km span and/or slopes greater than 6-10°). Track control is for bathymetry and bottom roughness.

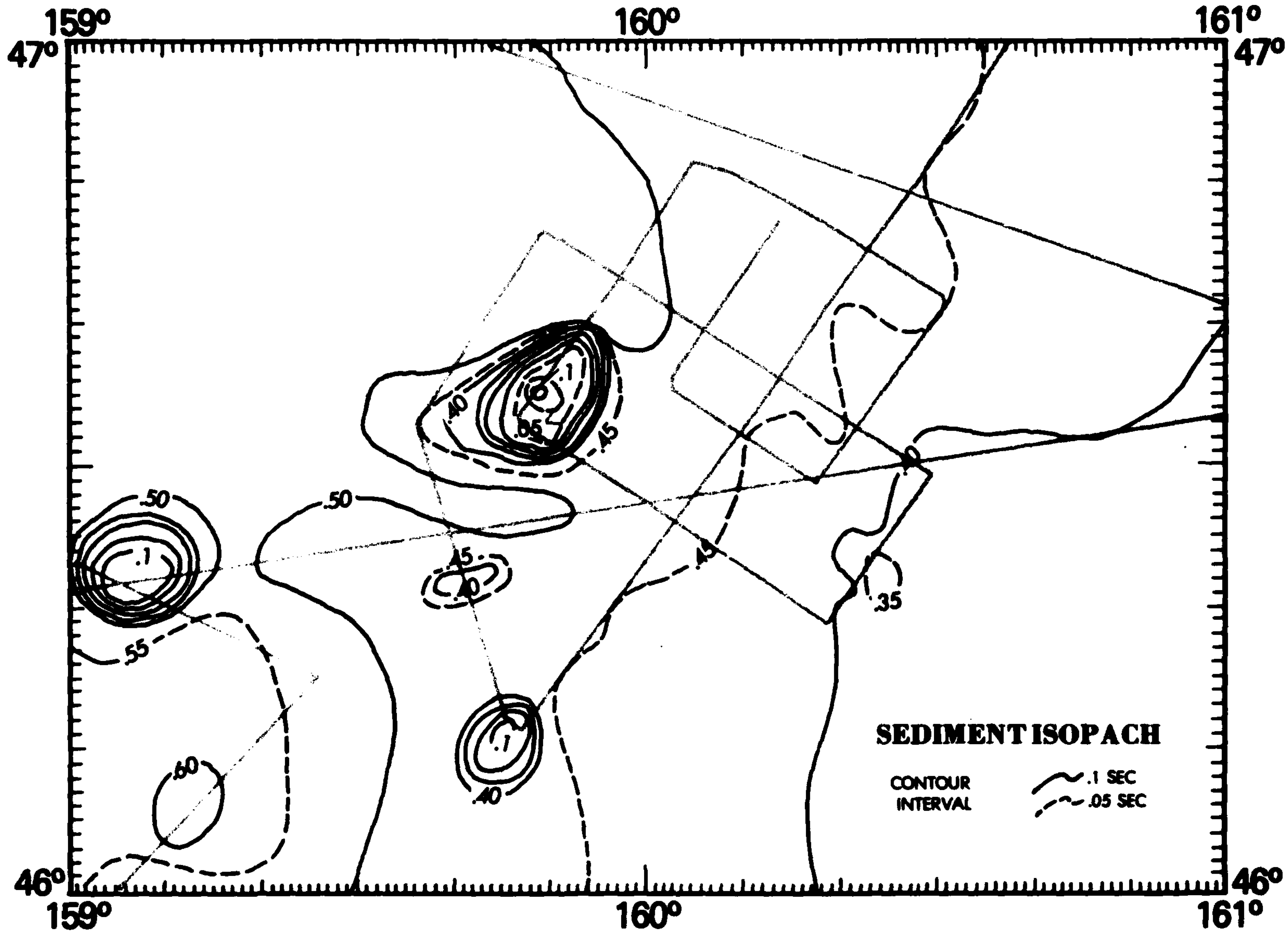


Figure 5. Sediment isopach of Area 2. Thickness shown in seconds of two-way travel time as compiled from continuous seismic reflection profiles. Track control is shown.

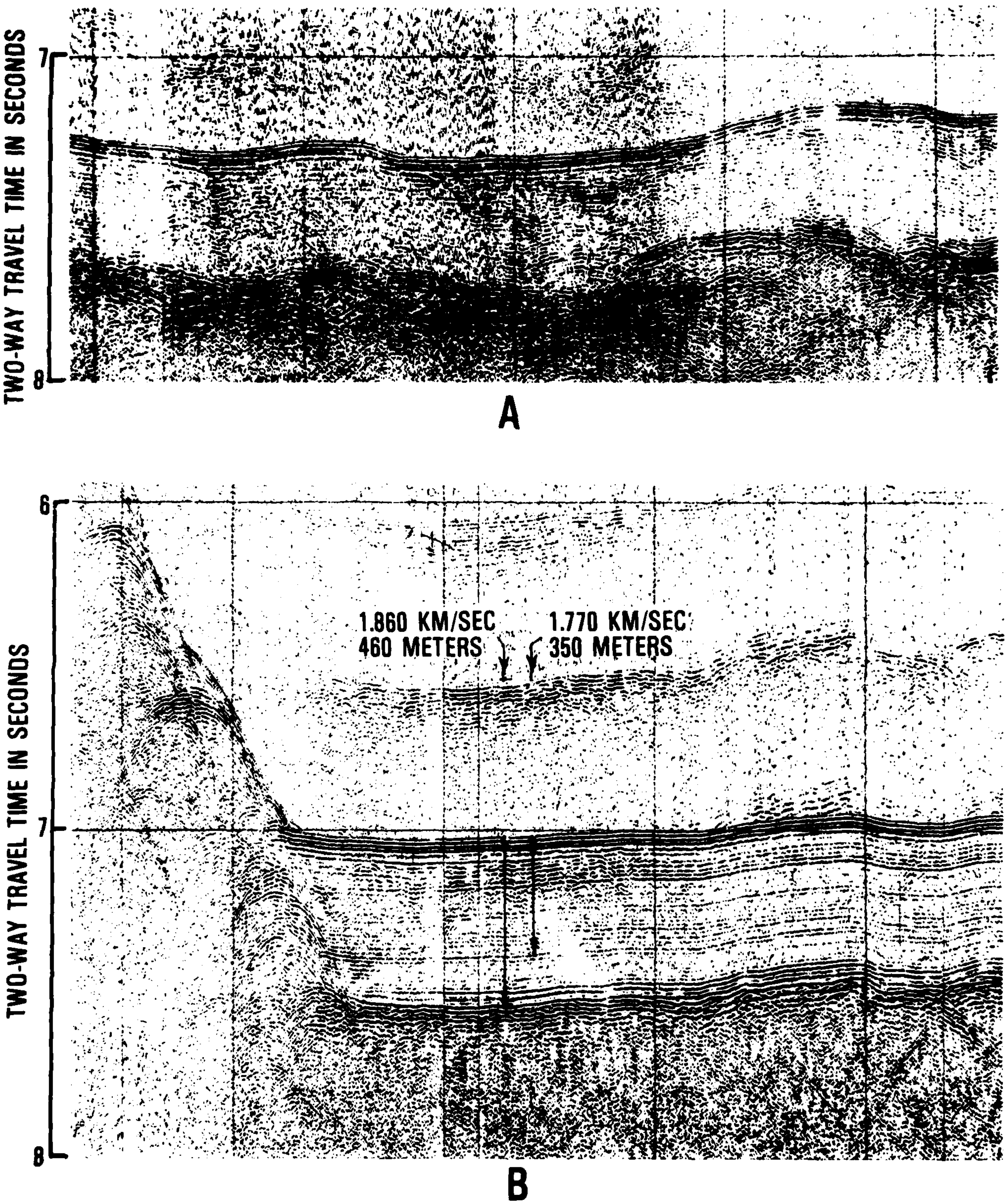


Figure 6. Selected continuous seismic reflection profiles (see Fig. 2 for locations). Profile A shows sediment ponding. Profile B shows smooth basement and bottom at the base of a seamount. Acoustic velocities are shown for measured vertical sections based on sonobuoy record 8.

conditions were deemed suitable for reliable interval velocity determinations (Fig. 6B).

Interval velocities were computed according to the LePichon method (LePichon et al., 1968) adapted for use on NORDA's computer facilities. Assumptions were: (1) flat-lying layers, (2) a mixed-layer velocity of 1490 m/sec and (3) an average water column velocity of 1500 m/sec.

Two solutions were computed for sonobuoy station number 8 (Fig. 6B). A velocity of 1.860 km/sec (±0.055 km/sec) for a 460 m layer was found for the interval from the seabed to the deepest horizontal reflector, possibly the top of what is referred to as 2A (Houtz and Ewing, 1976). A velocity of 1.770 km/sec (±0.125 km/sec) for a 350 m layer was found for an interval from the seabed to a reflector somewhat shallower than layer 2A.

Each of the solutions is comparable to other solutions made in the Northwest Pacific (Houtz et al., 1970). These solutions are also comparable to assumed sediment velocities for the Pacific Basin of 1.74 km/sec (Houtz and Ludwig, 1979).

D. ACOUSTIC BASEMENT

Figure 7 shows depth to acoustic basement with basement roughness superimposed. Although acoustic basement is generally rougher than bottom roughness, the smoothest and roughest areas for both generally coincide. Smoothest acoustic basement is around the base of the seamount located at 46.6°N, 159.8°E (Fig. 6B). This basement probably consists of secondary volcanic material derived from the adjacent seamount. Isostatic subsidence of the basement is apparent at the base of the seamount (Fig. 6B). Intermediate roughness areas are most widespread and are generally associated with tensional faulting which trends northeast-southwest. Acoustic basement for these areas might be composed of true oceanic basement which originally formed at a spreading ridge, secondary volcanics, or consolidated sediments such as chert lying on top of true basement. If chert is present, it should not exceed 40 m thickness because the underlying crust probably formed outside the high silica-producing zone (Green and Fleischer, 1980). The roughest acoustic basement is generally associated with slopes of seamounts and is probably oceanic basalt.

E. RESIDUAL MAGNETIC ANOMALIES

Figure 8A shows profiles of residual magnetic anomalies plotted on the track control, and Figure 8B presents an interpretation of the anomalies. Visual inspection of the profiles indicates that lineations of magnetic anomalies trend N60°E for northeastern areas of the survey, that no apparent lineations exist in western areas, and that a 100+ anomaly is associated with the seamount at 46.6°N, 159.8°E.

The lineations in the northeast have the same trend as the Mesozoic Japanese lineations mapped to the south (Hilde, 1976). Area 2 lineations might represent Cretaceous quiet zone (CQZ) seafloor spreading anomalies because Area 2 anomalies are oriented correctly and have small amplitudes; however, standard anomaly configurations for CQZ anomalies are unknown so the existing anomalies cannot be identified or dated. The lineations could also represent structural features such as parallel faults (D. Handschumacher, pers. comm.), but the anomalies do not appear to coincide with observable structure.

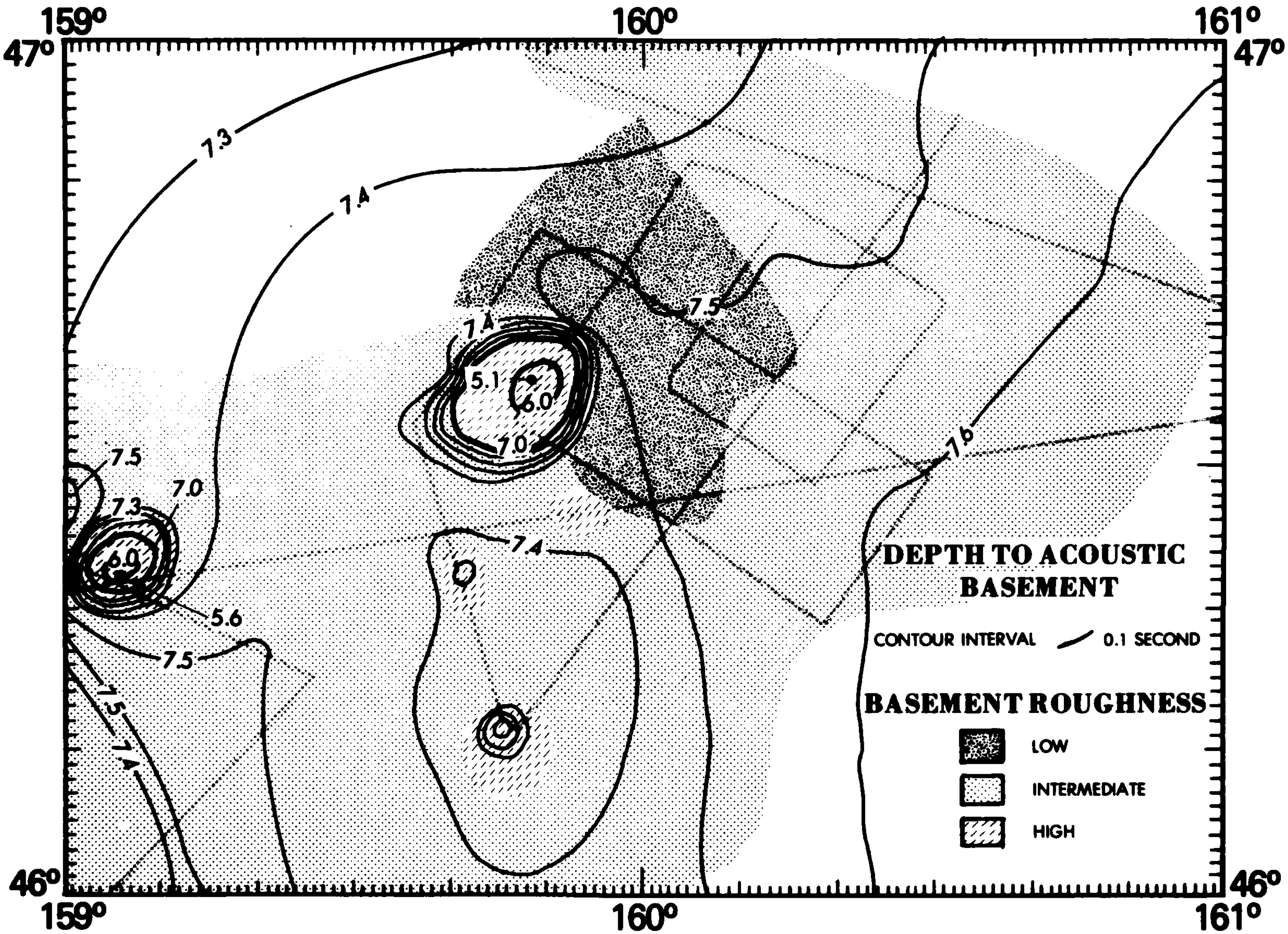


Figure 7. Depth to acoustic basement and basement roughness with track control. Depth to acoustic basement shown in seconds of two-way travel time based on continuous seismic reflection profiles. Basement roughness divisions are: low roughness (less than 200 m relief in a 20 km span and/or slopes less than 3–4°); intermediate roughness (intermediate relief and slopes of 3–10°); high roughness (relief greater than 200 m in a 20 km span and/or slopes greater than 6–10°).

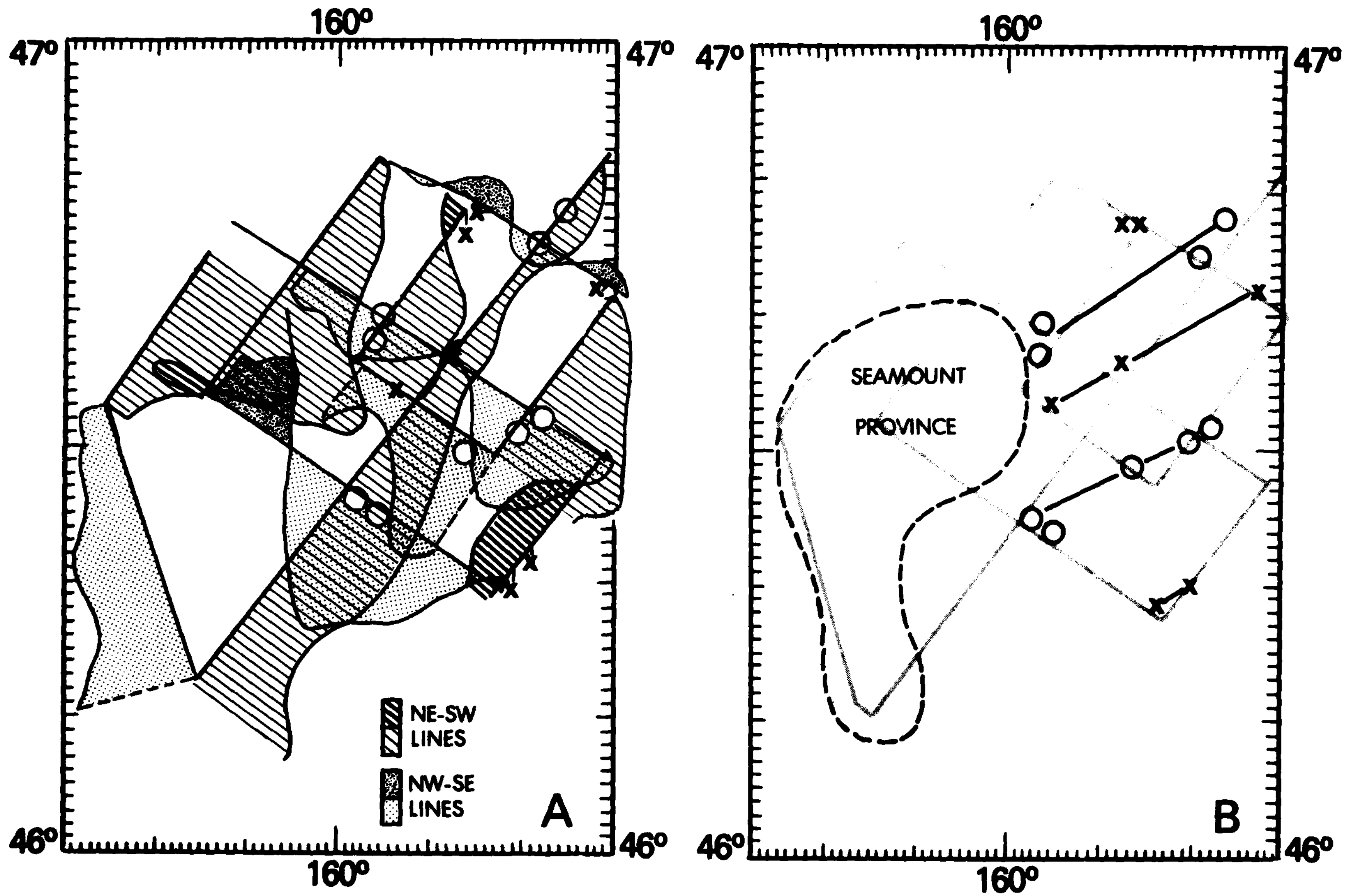


Figure 8. Residual magnetics data. Profiles are shown with the track control on 8A. Vertical scale is 100 γ/inch and profiles are normalized to $-250\,\gamma$ on the track control. Interpretation of the anomalies is shown on 8B. The western area has seamounts and local structural anomalies. The northeastern area shows lineations. Locations of relative troughs are represented by 0's, and +'s represent location of relative peaks.

Anomalies in the western area are probably caused by local structural features. The basement and bottom are generally rough, and no lineations of anomalies are apparent for this area. Seamounts are associated with the largest anomalies.

IV. CONCLUSIONS

Data from the two-day SILAS BENT Cruise greatly added to our knowledge of the local geology of Area 2. The area, approximately 40 km by 60 km, has relatively smooth bottom and basement for broad expanses and apparently homogeneous geology. No evidence was found for significant bottom currents, recently active faulting, or high energy sedimentation regimes. The northeastern section of the survey measuring 25 km by 25 km appears to have the smoothest bottom and most homogeneous geology. The presence of magnetic lineations in this area implies that seamounts are absent because seamounts normally have distinctive anomaly patterns.

The data in this note generally agrees with that of Green and Fleischer (1980). Area 2 was selected as a survey area because two continuous seismic reflection profiles indicated that the bottom and acoustic basement were smooth and that seamounts were absent. The data coverage for Area 2, as with most Northwest Pacific locations, was rarely better than 50 km spacing. The 1980 survey consists of 10 km spacing which should be sufficient for detecting major seamounts. Probably no major physiographic features have been overlooked by the survey. The major disagreement between the 1980 survey and the Green and Fleischer compilations is the presence of a 1400 m seamount in the western section of the survey area. The smoothest bottom and acoustic basement generally coincide with the base of this seamount, an occurrence which might prove useful in detecting seamounts in other Northwest Pacific locations.

Data concerning magnetic anomalies and sediment velocities fill data voids of the Green and Fleischer report. The magnetic lineations mapped in the northwestern section of Area 2 might be the first documented lineations for the Cretaceous quiet zone of the Northwest Pacific.

On the other hand, the survey data are insufficient for various analyses. No sediments were collected and we must rely upon previously collected sediment descriptions and physical properties data. The magnetics and seismic reflection data were not collected with close enough spacing to map small scale faulting, physiographic trends and magnetic lineations. Knowledge of the acoustic velocity structure of sediments and crust are poor. For more detailed velocity information on the sediments and underlying layers, it will be necessary to use energy sources with greater penetration capacity than can be achieved with 30 KJ sparkers. Also, more precise velocity information could be achieved using ocean bottom seismometers or a deep-towed geophysical array.

V. REFERENCES

Green, J. A. and P. Fleischer (1980). Environmental Report of the Northwest Pacific Ocean for the Marine Seismic System (MSS). NORDA Report 31.

Hilde, T. W. C., N. Isezaki and J. M. Wageman (1976). Mesozoic Seafloor Spreading in the North Pacific. IN: Geophysical Monograph 19, AGU, p. 205-226.

Houtz, R. and J. Ewing (1976). Upper Crustal Structure as a Function of Plate Age. J. Geophys. Res., 81, p. 2490-2498.

Houtz, R., J. Ewing and P. Buhl (1970). Seismic Data from Sonobuoy Stations in the Northern and Equatorial Pacific. J. Geophys. Res., 75, p. 5093-5111.

Houtz, R. and W. Ludwig (1979). Distribution of Reverberant Subbottom Layers in the Southwest Pacific Basin. J. Geophys. Res., 84, no. B7, p. 3497-3504.

LePichon, X. J. Ewing and R. Houtz, (1968). Deep-Sea Sediment Velocity Determination Made While Reflection Profiling. J. Geophys, Res., 73, p 2597-2614.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NORDA Technical Note 81	2. GOVT ACCESSION NO. AD-A098902	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) Data Report for Oceanographic/Geophysical Surveys in the Northwest Pacific (46-47°N, 159-161°E): USNS Silas Bent, 2-3 August 1980.		5. TYPE OF REPORT & PERIOD COVERED (9) Final rept.
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) J. A./Green S. D./Trowell (14) NORDA-TN-81		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Ocean Research & Development Activity Ocean Science & Technology Laboratory, Code 360 NSTL Station, Mississippi 39529		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (12) 21
11. CONTROLLING OFFICE NAME AND ADDRESS Same (11)		12. REPORT DATE March 1981
		13. NUMBER OF PAGES 15
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Geophysical/Oceanographic Survey
Hokkaido Rise
Unconsolidated sediment
Acoustic basement
Magnetic lineations

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This note presents the results of a geophysical/oceanographic survey of Area 2 selected from Green and Fleischer ("Environmental Report of the Northwest Pacific Ocean for the Marine Seismic System," NORDA Report 31, 1980). The surveyed area has an average depth of 5300 m and is located on the eastern flank of the Hokkaido Rise. Average unconsolidated sediment thickness is 0.45 seconds of two-way travel time (approximately 400 m). These sediments are probably siliceous clays interspersed with volcanic ash layers, and their

calculated acoustic interval velocity is 1.770-1.860 km/sec.

The smoothest bottom and most homogeneous geology appear in the northeastern section of the survey area. This section, an area about 25 km x 25 km, has smooth acoustic basement which is present at the northern base of a seamount located at 46.6°N, 159.8°E. Residual magnetic lineations are also present in this area and may represent Cretaceous quiet zone seafloor spreading anomalies.

In the western part of the survey area the bottom and acoustic basement are rougher than in the eastern part. The local geology is less homogeneous because seamounts are present. Residual magnetic anomalies are generally associated with seamounts and no correlatable lineations are apparent.

DATE

ILME